sanwa

N-401F
MULTITESTER

sanwa
SANWA ELECTRIC
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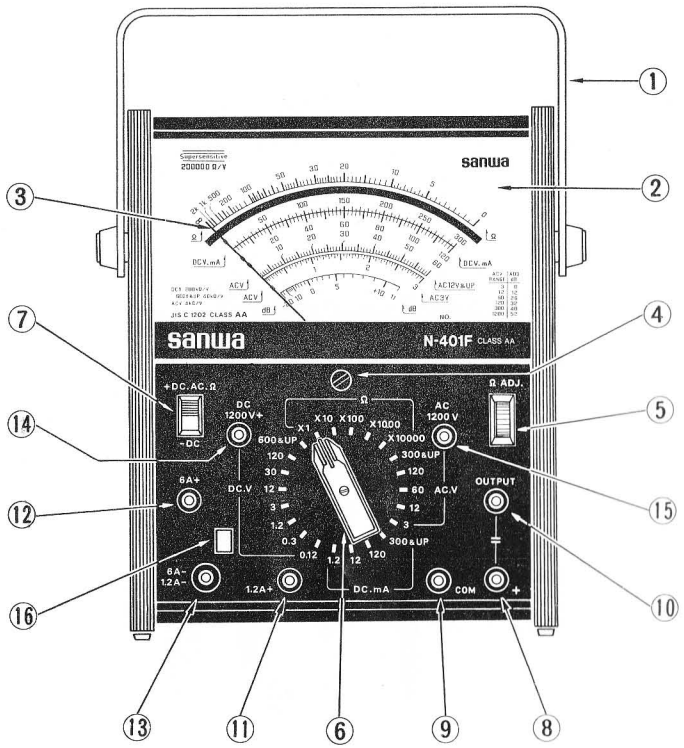
OPERATOR'S MANUAL



① Rigid handle serving as prop stand
② Indicator
③ Pointer
④ Scale-zero corrector
⑤ Zero-ohm adjuster
⑥ Range selector switch knob
⑦ Polarity reversal switch
⑧ Positive (+) terminal
⑨ Negative common terminal
⑩ Series condenser terminal
⑪ DC 1.2A+ terminal
⑫ DC 6A+ terminal
⑬ DC 1.2A & 6A common − terminal
⑭ DC 1200V exclusive + terminal
⑮ AC 1200V exclusive + terminal
⑯ Neon lamp

MAINTENANCE FOR SAFETY OPERATION

To be sure, a circuit tester is a very useful measuring gear capable of checking voltage, current, resistance, and various other electric and electronic quantities and phenomena. Accordingly, the object of measurement it covers varies widely from minute current to high voltage. Into the bargain, input impedance changes from a few ohms up to high megohm level as measurement ranges are cut over. Such uniqueness of a tester demands the operator to use utmost care in its operation and maintenance to ward himself off danger as well as damage to the meter. Especially when checking high-power equipment, no operation mistake should be committed.

A circuit tester needs periodical inspection and calibration to maintain it in good operative condition. A tester known to be defective or laid away unused for many months must not be used. Be certain to have your meter undergo warrantable inspection at least once a year, when the correct position of the range knob must be ascertained, and withstand voltage test not be omitted. A test lead with a fuse sealed in (TLF-70B) is available extra. It will surely serve to prevent possible danger.

CONTENTS

INTRODUCTION

The N-401F is a full-size, ultra-high sensitivity circuit tester equipped with a taut-band suspension meter movement of 5uA full scale. Composed of standardized parts and materials, the instrument furnishes high stability performance. In fact, it stands higher above the conditions attached in conformity to the Japanese Industrial Standard as essential to Class AA circuit testers (JIS C1202). Refer to the following table:

Table 1

Item	JIS Class AA	N-401F
No. of measurement ranges	Above 20 ranges	31 ranges
Arc length	Above 55mm	115mm
Full-scale operating current	Below 60uA	5uA
Input impedance for DCV	Above 18kΩ /V	200kΩ /V
Terminal voltage drop	Below 500mV	300mV
Input impedance for ACV	Above 1.8kΩ /V	4kΩ /V
Maximum frequency coverage	20kHz (±3%)	50kHz (±3%)

FEATURES

1 5uA meter movement.

The ultra-high sensitivity 5uA taut-band suspension meter movement furnishes such high internal impedance as 200kΩ /V for DC voltage measurement to result in practically no current dissipation giving no disturbance to the condition of the circuit being checked. A suspension meter movement is featured in freedom from friction to cause erroneous reading.

2 Quick response to indication—less than 3.7sec.

It has so far been considered a structural shortcoming of a high sensitivity large-size circuit tester that its response to indication is generally slow. Challenging the 4-sec. that JIS provides for Class AA circuit testers, and in spite of the handicapped 5uA sensitivity, we have successfully governed it to reduce the speed of response to below 3.7 seconds full scale for all measurement ranges by reasonably determining the constant of the magnetic circuit and moving coil. It is usual with a 10uA full scale meter to take 4～5 seconds to have the pointer come to a standstill for, say, DC 250mA range.

3 Design for safety operation.

To promote safety of operation, the following measures are taken:

(1) Fuse fitted up.
Burnout damage through misapplication and unforeseen disaster to the operator that sparking may cause are prevented.

(2) Secure plugging.
300gr is the force allowable as standard, while the specifically devised terminal jack action firmly catches the pin plugged in: it would not come off by the force of 1kg applied to it.

(3) Withstand voltage twice the highest voltage rating plus 1000V.
The voltage range of the instrument is rated to read 1200V at maximum, so it stands 3400V as totalled.

4 Polarity reversal switch.

A turn of the switch readily measures +DC or − DC without the trouble of reversing the connections of the test leads. It is made good use of when checking FM and transistor circuits.

5 Protective side boards.

The walnut side boards which characterize the appearance of the instrument not only protect it from impact on the side, but they also serve to seat the meter stable on the workbench.

6 Well-selected materials.

All the major components including switches and resistors that the instrument is made up of have undergone rigorous type test at competent inspection agencies, not to speak of the factory's routine inspection.

SPECIFICATIONS

Table 2

Measurement	Maximum reading	Allowance	Remarks
DC voltage	0.12—0.3—1.2—3—12—30—120—600—1200 (V)	±2% fsd	Input impedance: 200kΩ/V (40kΩ/V for 600V & above
AC voltage	3—12—60—120—300—1200 (V)	±3% fsd	Input impedance: 4kΩ/V
DC current	1.2—12—120—300 (mA) 1.2—6 (A)	±2% fsd	Terminal voltage drop: 300mV
Resistance	2k—20k—200k—2M—20M (Ω)	Within ±3% of arc	Midscale: 20Ω for ×1 range
AF output	+11 for 3V AC 23~37~43~51~63 (dB)	±3% fsd	Input impedance: 12kΩ & above for 3V AC range

Normal operating position:	Level at 20°C
Insulation resistance:	Above 100MΩ at 1000V DC
Dielectric strength:	3400V AC/min
Internal battery:	1.5V (UM-2) x1
Accessories supplied:	Test leads (pair) 1
	Operator's manual 1
Spare fuse:	3 (1 fitted inside)
Dimensions & weight:	252×190×103mm & 1.8kg approx

OPERATION (Refer to FRONTAL ACCESS.)

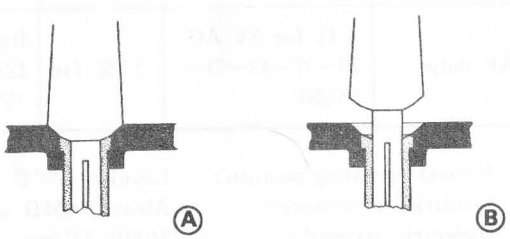
1 Zero correction of indicator.

Whenever the pointer ③ is found off 0 of the scale left, the zero-corrector ④ is adjusted to place it at 0.

2 Connections of test leads.

The test lead plugs are inserted well down into the jacks to use. Correct connection is illustrated in Fig. 1-A, where the metal part of the plug is completely buried in the jack: it would not come off by the force of 1kg applied to it. 2-B illustrates false plugging.

Fig. 1



Correct plugging is only available for the standardized test leads.

3 Use of polarity reversal switch.

For general measurements, the polarity switch

⑦ is placed at +DC. AC. It is turned to −DC for negative DC voltage and current measurements.

4 Measuring ±DC voltage−0.12V~1200V

4-1 DC voltage is measured in 9 ranges. Positions of the range switch, scale to use and other measuring factors are as shown in the following table:

Table 3

Switch position	Maximum reading	Terminals	Scale to use	Multiplying factor & unit
0.12	0.12V (120mV)	+ & COM	0-120 DCV·mA	0.001 in V 1 in mV
0.3	0.3V (300mV)	〃	0-300 〃	〃
1.2	1.2V	〃	0-120 〃	0.01 in V
3	3V	〃	0-300 〃	〃
12	12V	〃	0-120 〃	0.1 in V
30	30V	〃	0-300 〃	〃
120	120V	〃	0-120 〃	1 in V
600&UP	600V	〃	0-60 〃	10 in V
〃	1200V	DC 1200V + & COM	0-120 〃	〃
〃	30kV *	See Fig.4	0-300 〃	0.1 in kV

* Using HV probe (see 4-5).

4-2 The DC 0.12V (120mV) range functioning as galvanometer.

The voltage sensitivity of the 0.12V range is 2mV, and the current sensitivity 8.3×10^{-8} A per scale. This range performs the meter as a galvanometer for checking unbalanced voltage and measuring thermoelectromotive power. As ammeter, it reads 5uA full scale for this range.

4-3 High performance 5uA/200kΩ/V meter movement.

Measurement loss is practically nil. See Fig. 2, where the actual DC voltage at point P is 10V. Table 4 reveals how accurate is the value measured by N-401F as compared with that by usual testers.

Fig. 2

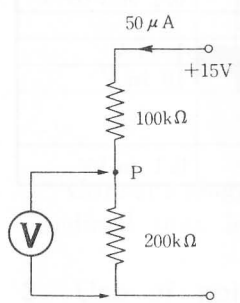


Table 4

Type of tester employed	Indication	Error by loss
N-401F (on DC 12V range)	9.66V	-3.4%
20kΩ/V tester (on DC 10V range)	7.5V	-25%
Low sensitivity tester	3.73V	-63%

So small is the loss by N-401F that it performs equal to a valve- or a transistor-voltmeter to obtain dependable data unattainable by usual testers in measuring a voltage amplifying circuit, DC amplifier, oscillating current, AVC, AGC and transistor circuits in general.

4-4 Function of polarity reversal switch.

When measuring DC voltage, if the pointer moves to reverse direction across 0, the polarity switch is turned to −DC to read. It is not necessary to reverse the connections of the test leads; the lead on the COM jack is left connected to ground. Correct −DC measurement is essential when checking FM and transistor circuits.

4-5 HV probe and TV circuit servicing.

The high anode voltage of CRT and focusing voltage of color TV are measured by using the HV probe available extra. Connections are shown in Fig. 3.

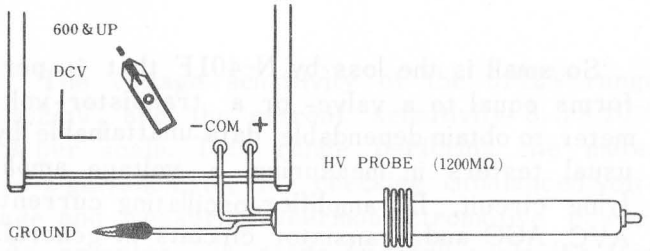


Fig. 3

Note. High voltage measurement by the probe is only applicable to low-power, high impedance circuits.

5 Measuring AC voltage− 3V~1200V.

5-1 AC voltage is measured in 6 ranges. The position of the range switch, scale to use, and other measuring factors are as shown in the following table:

Table 5

Switch position	Maximum reading	Terminals	Scale to use	Multiplying factor & unit	Corresponding dB scale *
3	3V	+ & COM	0-3 ACV	1 in V	−20~+11
12	12V	〃	0-120 AC12VUP	0.1 in V	− 8 ~+23 (+12dB)
60	60V	〃	0-60 〃	1 in V	+ 6 ~+37 (+26dB)
120	120V	〃	0-120 〃	〃	+12~+43 (+32dB)
300 & UP	300V	〃	0-300 〃	〃	+20~+51 (+40dB)
300 & UP	1200V	AC 1200V & COM	0-120 〃	10 in V	+32~+63 (+52dB)

* 0dB is estadlished at the voltage where 1mW is dissipated across 600Ω line. Parallel capacity between terminals across + and COM is approximately 20pF.

5-2 Frequency characteristic.

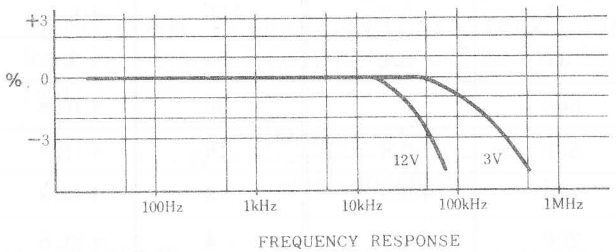


Fig. 4

As the graph shows, the frequency response for AC measurement goes over the usual limit of 20kHz. It is indeed 300kHz for the 3V range and 50kHz for the 12V range. It is good enough for checking audio circuits, and the instrument performs as an output voltmeter and monitor meter. The dB scale will afford added efficiency.

5-3 dB scale.

The dB scale is graduated on the reference of 0dB for 1mW output across 600Ω line. Therefore, the output power of a circuit coordinated to 600Ω load impedance is readily obtained by tranferring the AC voltage reading onto the dB scale. For a circuit other than 600Ω impedance, true output dB is obtained through the following conversion table:

Table 6

Load(Ω)	dB to be added	Load(Ω)	dB to be added
2k	−5.2	150	+6.0
1k	−2.2	75	+9.0
600	0	50	+10.8
500	+0.8	16	+15.8
300	+3.0	8	+18.8
200	+4.8	4	+21.8

5-4 Measuring output power in W.

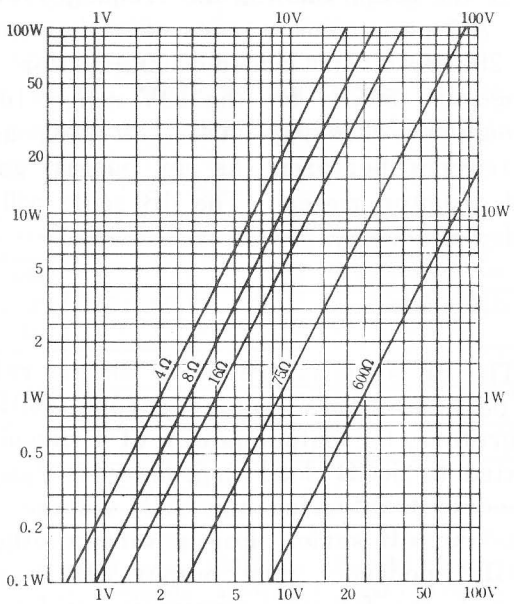


Fig. 5

In reference to the graph, providing the tester reads 4V on the AC 12V range for a load impedance of 8Ω, output will be 2W. Equation follows:

$$W = \frac{(\text{Output ACV})^2}{\text{Load impedance}}$$

5-5 OUTPUT terminal and AC voltage measurement.

The positive lead is replugged into the OUTPUT jack leaving the negative lead connected to COM. In this measurement, the 0.1uF capacitor connected in series with these terminals blocks the DC element present in the circuit being measured, so that the AC signal alone is read isolated.

6 Measuring high DC and AC voltage above 300V.

Be sure to observe the following cautions when checking a circuit containing high power voltage above 300V.

6-1 Before connecting the tester to the circuit, switch off power source, and confirm each smoothing capacitor placed in the circuit discharged.

6-2 Reascertain the correct position of the range switch and the test lead connections on the right jacks.

6-3 Power is switched on and reading is noted. While taking the reading, keep off your hands from the tester, test leads and the circuit under test.

6-4 After reading is taken, power is switched off and the test leads are disconnected, but not before the pointer is noted to have returned to 0.

6-5 However, a high impedance and low current circuit of television and communication apparatus can de measured in usual manner.

7 Measuring ±DC current—1.2mA~300mA and 1.2A~6A.

7-1 For voltage measurement, the tester is connected in parallel with load, while for current measurement, it is connected in series, for which the circuit under test is opened.

7-2 DC current is measured in 6 ranges. Refer to the following table for measuring factors:

Table 7

Switch position	Maximum reading	Terminals	Scale to use	Multiplier & unit to read
1.2	1.2mA	+ & COM	0-120 DCV. mA	0.01 in mA
12	12mA	〃	〃	0.1 〃
120	120mA	〃	〃	1 〃
300 & UP	300mA	〃	0-300 〃	1 〃
* 300 & UP	1.2A	1.2A+ & 1.2A—	0-120 〃	0.01 in A
* 300 & UP	6A	6A+ & 6A—	0-60 〃	0.1 〃

* Instead of + and COM, exclusive jacks are used.

8 Measuring resistance—0.5Ω ~ 20MΩ.

8-1 Zero-ohm adjustment.

Before measurement, the + and COM jacks are shorted, and ΩADJ ⑤ is turned up and down to adjust the pointer to stay exactly at 0 of the top Ω scale. It must be adjusted each time the range is moved.

8-2 Measuring factors and current consumption for each range are shown in the following table:

Table 8

Switch position	Minimum reading	Midscale reading	Maximum reading	Maximum current consumption (terminals shorted)	Maximum impressed voltage (terminals open)
×1	0.5Ω	20Ω	2 kΩ	75mA	1.5V
×10	5Ω	200Ω	20 kΩ	7.5mA	〃
×100	50Ω	2kΩ	200 kΩ	750uA	〃
×1000	500Ω	20kΩ	2MΩ	75uA	〃
×10000	5kΩ	200kΩ	20MΩ	7.5uA	〃

8-3 Replacement of battery.

As the internal battery wears out, its internal resistance increases making it impossible to adjust the pointer to 0Ω for ×1 range. In that case, the battery must be replaced immediately. The battery is mounted in the case on the rear. Remove the cover and replace the battery with a fresh one. (Fig. 6)

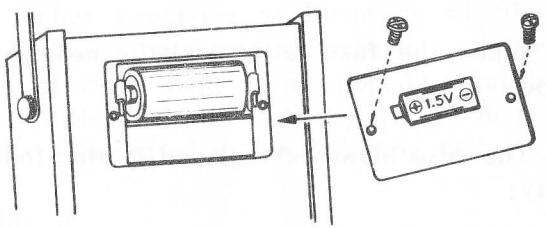


Fig. 6

8-4 Terminal polarity for resistance measurement.

When checking the resistance of a diode or transistor, and the leakage of an electrolytic capacitor, their polarity must be taken into account. As a rule, the + jack of a tester is connected to the negative pole of the battery. So the voltage furnished to the + and − terminals is reversed. Be aware of it when checking polarized resistance.

9 Replacement of fuse.

9-1 Majority of accidenet to occur in the tester is burnout damage. It is caused by AC voltage —mostly 100V, 220V or 440V—inadvertently applied to a current or the ×1 resistance range. Their internal resistance is 1Ω for the 3mA range and 20Ω for the ×1 range. N-401F has a fuse fitted up inside which blows to protect the instrument, should an error be committed.

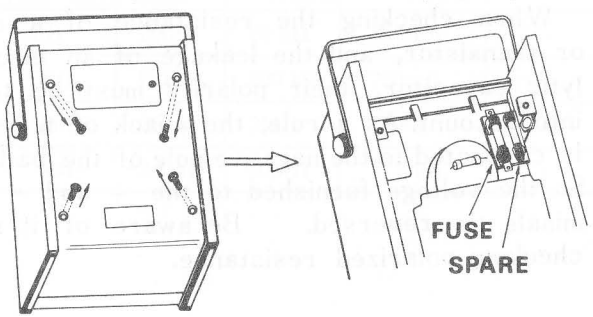
9-2 When the fuse is blown, the neon light ⑯ glows to signal it.

9-3 The fuse blown is replaced in the following way:

(1) 4 bolts on the rear are removed. (Fig. 7)

(2) Beside the indicator are mounted 2 fuses. The one blown is replaced with the spare fitted in pair. (Fig. 7)

Fig. 7



(3) Fit one of the 2 spares supplied in the fuse holder.

(4) After replacement, set the range switch for an ohm range and short the + and COM jacks to see if the pointer moves normally.

10 Taut-band suspension meter movement.

For higher precision performance of the 5uA ultra-high sensitivity meter movement, the moving element of it is held in position by taut bands. How it differs from ordinary pivot suspension system is illustrated in the following table:

Table 9

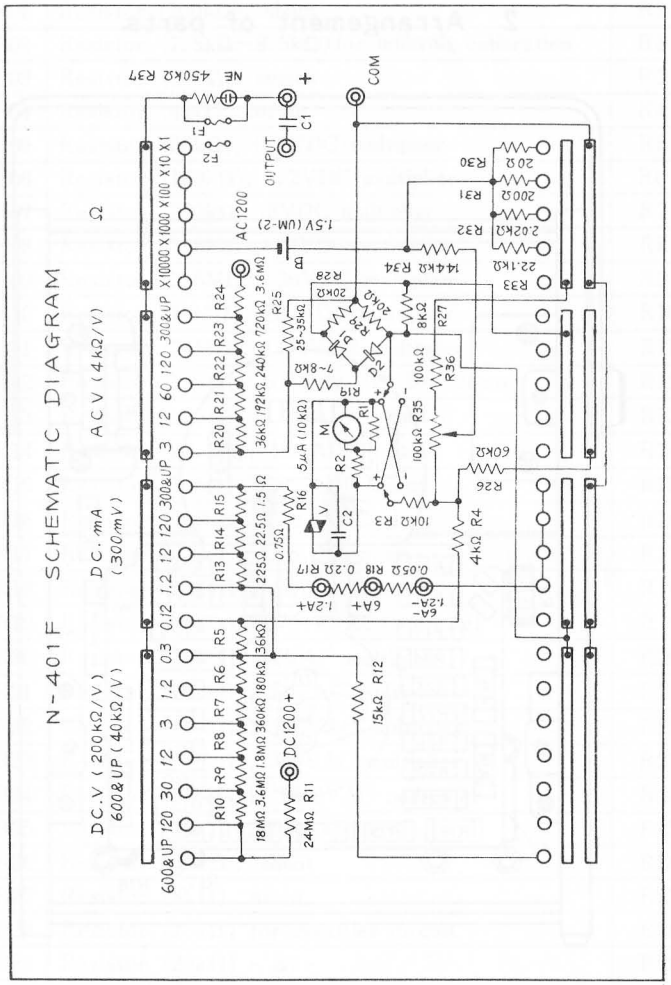
System	Merit	Demerit
Pivot system	Balance of pointer is good because the moving element is held in position by contact points.	Indication error is liable due to contact suspension. Inapplicable to a movement above 10uA in sensitivity.
Taut-band system	Less hysteresis error and exact indication without contact friction.	Pointer balancing is easy for a full-size meter on account of tensile suspension.

11 Front cover of indicator.

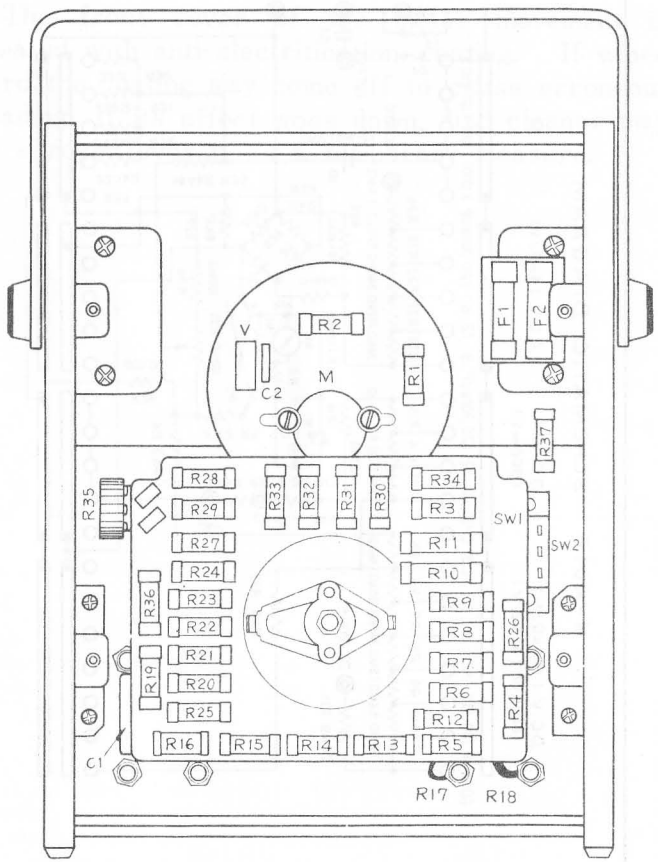
The front cover of the meter movement is treated with anti-electrification coating. If wiped hard, the coating may come off to cause erroneous reading. If its effect goes down, disc cleaner may be sprayed over it as a temporary measure.

SUPPLEMENTARY DATA

1 Schematic diagram.



2 Arrangement of parts.



3 List of parts.

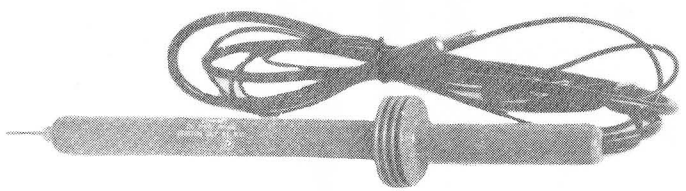
Part No.	Description	Symbol
4FR01	Resistor (200kΩ), shunt	R1
4FR02	Resistor (7.5kΩ~8.5kΩ) for millivolt calibration	R2
4FR03	Resistor (10kΩ), series	R3
4FR04	Resistor (4kΩ), series	R4
4FR05	Resistor (36kΩ), 0.3VDC multiplier	R5
4FR06	Resistor (180kΩ), 1.2VDC multiplier	R6
4FR07	Resistor (360kΩ), 3VDC multiplier	R7
4FR08	Resistor (1.8MΩ), 12VDC multiplier	R8
4FR09	Resistor (3.6MΩ), 30VDC multiplier	R9
4FR10	Resistor (18MΩ), 120VDC multiplier	R10
4FR11	Resistor (24MΩ), 1200VDC multiplier	R11
4FR12	Resistor (15kΩ), 600V & UP DC shunt	R12
4FR13	Resistor (225Ω), 1.2mADC shunt	R13
4FR14	Resistor (22.5Ω), 12mADC shunt	R14
4FR15	Resistor (1.5Ω), 120mADC shunt	R15
4FR16	Resistor (0.75Ω), 300mADC shunt	R16
4FR17	Resistor (0.2Ω), 1.2ADC shunt	R17
4FR18	Resistor (0.05Ω), 6ADC shunt	R18
4FR19	Resistor (7kΩ~8kΩ), 3VAC multiplier	R19
4FR20	Resistor (36kΩ), 12VAC multiplier	R20
4FR21	Resistor (192kΩ), 60VAC multiplier	R21
4FR22	Resistor (240kΩ), 120VAC multiplier	R22
4FR23	Resistor (720kΩ), 300VAC multiplier	R23
4FR24	Resistor (3.6MΩ), 1200VAC multiplier	R24
4FR25	Resistor (25kΩ~35kΩ), shunt	R25
4FR26	Resistor (60kΩ), shunt	R26
4FR27	Resistor (8kΩ), shunt	R27
4FR28	Resistor (20kΩ) for rectifier circuit	R28
4FR29	Resistor (20kΩ) - do -	R29

4FR30	Resistor (20Ω), ohm ×1 shunt	R30
4FR31	Resistor (200Ω), ohm ×10 shunt	R31
4FR32	Resistor (2.02kΩ), ohm ×100 shunt	R32
4FR33	Resistor (22.1kΩ), ohm ×1000 shunt	R33
4FR34	Resistor (144kΩ), ohm series	R34
4FR35	Potentiometer (100kΩ) for 0-ohm adjustment	R35
4FR36	Resistor (100kΩ), shunt	R36
4FR37	Resistor (450kΩ), neon lamp series	R37
FR05	Germanium diode, 2 required	D1, D2
M017	Meter movement (5uA taut-band type)	M
ZSW1	Range selector switch	SW1
PSW1	Polarity reversal switch	SW2
V001	Varister	V
C049	Capacitor (0.1uF)	C1
C050	Capacitor (0.05uF)	C2
N4P02	Front panel (N-401F type)	
X018	Rear case (N-401F type)	
N4T01	Terminal metal for drycell, 2 required	
N4BC2	Battery case cover	
T002	Terminal jack, 8 required	
K013	Knob for range selector switch	
C019	Meter movement cover	
BA02	Meter movement base	
L001	Test lead, pair	
S007	Side board w/metal fitting, 2 required	
H002	Handle w/fitting bolt, 2 required	
NE01	Neon lamp w/holder	
F001	Fuse (1A) w/holder	F1, F2
V003	Rear case bolt, 4 required	
B002	Drycell (1.5V UM-2)	B

75.3-1 S

HV probe available extra

(See page 11)



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